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NOMINATION—OSTP

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

ON

NOMINATIONS

FEBRUARY 28, 1990

DR. WILLIAM D. PHILLIPS AND DR. EUGENE WONG, TO BE ASSOCIATE DIRECTORS, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT

Printed for the use of the
Committee on Commerce, Science, and Transportation

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NOMINATIONS—OSTP

WEDNESDAY, FEBRUARY 28, 1990

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 10:07 a.m., in room SR-232A, Russell Senate Office Building, Hon. Albert Gore, Jr., presiding.

Staff members assigned to this hearing: Pat Windham, professional staff member and Ruth Johnson, minority professional staff member.

OPENING STATEMENT BY SENATOR GORE

Senator GORE. The hearing will come to order. I want to apologize to our nominees and guests for starting five minutes late. I went to the wrong hearing room. We are used to having hearings in a different room, and I hate to admit it but I went through my normal rat maze and was disconcerted to find out it was a different room.

Welcome to this hearing on the nominations of Dr. William D. Phillips and Dr. Eugene Wong to be Associate Directors of the White House Office of Science and Technology Policy. I am very pleased the President has moved to create a strong and capable OSTP, that he has named a truly excellent director and that he has nominated individuals to fill all four of the Associate Director positions authorized by law.

This nation faces huge challenges in science and technology, as we, among many others, documented during two days of general overview hearings of science and technology policy which our Subcommittee held last fall. In national security, economic competitiveness and the global environment, new national and international needs have arisen, complex needs that Federal research programs are being asked to help meet. So we very much need an effective OSTP.

If confirmed—and you, of course, will be confirmed—Dr. Phillips and Dr. Wong will play pivotal roles in advising the OSTP Director and the President on these issues. Dr. Bromley has indicated that Dr. Phillips will concentrate on industrial technology. Dr. Wong will focus on physical sciences and engineering, which means he will help to oversee a wide group of Federal science and technology programs ranging from university research to defense, space and energy.

I am deeply concerned about both of these issue areas. I will put the full text of my opening statement in the record and elaborate

on the concerns in each of the two areas that we are going to be discussing here today.

If we lose the semiconductor industry, the computer industry, the automobile industry, and others, we will forfeit not only income and wealth but also much of our control over our own national life. I am pleased that the President's new budget acknowledges the importance of competitiveness, but, frankly, I must say that the budget's priorities seem skewed. Huge science projects with little practical value to the economy are favored, while research to develop the generic technologies that industry needs to stay competitive remains very small. I intend to explore this issue further during today's hearing.

I am also concerned about the government's research programs in the physical sciences and engineering, and for a similar reason. In the rush for a few big projects, I worry that we are neglecting the government's "technology infrastructure." Both Federal agencies and the private sector depend on maintaining a research infrastructure of up-to-date equipment, new enabling technologies, and trained people. Yet we seem to have trouble finding money to upgrade this infrastructure. Examples range from data management facilities for our global change research program to under-investment in long-term technology development for space exploration.

I am particularly concerned about high-performance computing. Computers and the networks which link them are now among the most essential tools for scientific and engineering research. OSTP recognized the importance of upgrading this research system when it prepared a major high-performance computing initiative in November 1987, a report written in response to legislation that I authored in 1986. There is strong support for implementing the report's recommendations, but the President's fiscal year 1991 budget requests only $21 million in new funds for this essential initiative, far short of the $1.7 billion recommended by OSTP itself. If we continue to short-change the future, both Federal research and the nation's long-term technical capabilities will suffer greatly.

These are important issues, and I look forward to exploring them this morning with Dr. Phillips and Dr. Wong. Both of them come to us today with eminent credentials.

Dr. Phillips is a highly-regarded chemist with long experience in both industry and academia. Most recently, he has served as Science Advisor to the Governor of Missouri and headed that state's Advanced Technology Institute. He is a member of the National Academy of Sciences.

Dr. Wong is an electrical engineer and one of the nation's top computer scientists. He worked for IBM earlier in his career and since 1962 he has been a professor in the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley. He is a member of the National Academy of Engineering.

Gentlemen, we are very pleased to welcome you to this confirmation hearing. I know that Senator Danforth hopes to be able to introduce Dr. Phillips. Dr. Wong, I am sorry that scheduling conflicts prevented the California Senators from attending this morning, but your outstanding qualifications provide an excellent introduction.

Now, without any further ado, I want to recognize the ranking member of our full Committee, Senator Danforth.

OPENING STATEMENT BY SENATOR DANFORTH

Senator DANFORTH. Mr. Chairman, thank you very much. I am here in a somewhat different role than a member of the Committee. I am here to present to you Dr. Bill Phillips, who is a native Missourian. He was born in Kansas City and he has lived much of his life in St. Louis, where he has been associated in various capacities with both Washington University and the Mallinckrodt Chemical Company.

He did, as I think you pointed out, serve for some time, 27 years, with duPont, and then he returned to Missouri and he became Chairman of the Department of Chemistry and Professor of Biological Chemistry at the School of Medicine, Washington University. He also served as the Director of Washington University's Center for Biotechnology.

After four years at Washington University, he was named senior vice president for science and technology at Mallinckrodt and, as you pointed out, he has served as the science advisor to our Governor, John Ashcroft.

Mr. Chairman, clearly one of the interesting issues we should be thinking about is the relationship between academia, industry and government in advancing our country in the field of science and technology. Dr. Phillips knows all three, and I really commend the President and Dr. Bromley for bringing him before us. I look forward to an early confirmation. I think that he offers us some insights and experience on this crucial interrelationship which will be essential to the well-being of our country in the years ahead.

Senator GORE. Thank you. That is a very strong recommendation indeed, Dr. Phillips. Why do we not begin with you. If you have an opening statement we would be delighted to hear it.

First, let me include in the record, statements from the Chairman, Senator Hollings and Senator Pressler.

[The statements, biographical sketch, and prehearing questions and answers follow:]

OPENING STATEMENT BY THE CHAIRMAN

I am pleased that the Committee is holding this morning's hearing on the nominations of Dr. William D. Phillips and Dr. Eugene Wong to be Associate Directors of the White House Office of Science and Technology (OSTP).

OSTP, if properly staffed and organized, can play a very important role in advising the President, setting policy, and coordinating the increasingly interconnected science and technology programs of the Federal government. When the process works well, the results can be very positive, as in the case of the Federal global change research plan prepared by an interagency committee under OSTP's supervision. I have been impressed by this interagency committee, and the Senate recently passed my legislation, S. 169, to institutionalize and strengthen its planning process.

In this new Administration, the President has nominated a very able scientist to be Director of OSTP, and all four individuals nominated to be Associate Directors, two of which already have been confirmed, have excellent credentials. I was pleased to support the nominations of Dr. Wyngaarden and Dr. Ratchford, and I look forward to today's review of the qualifications of Dr. Phillips and Dr. Wong. I believe it is in everyone's interest to have a strong, competent OSTP, and I will continue to work towards that goal.

Opening Statement by Senator Pressler

Mr. Chairman, I would like to congratulate the two nominees for Associate Directors of the White House Office of Science and Technology Policy, Dr. Phillips and Dr. Wong.

Congress created the Office of Science and Technology Policy in 1976 because it recognized the importance of science and technology to the welfare of our nation. Our economy, our health, our environment, and our national security all depend on our strong base in science and technology.

The Office of Science and Technology Policy is the central science policy office in the Executive branch. It helps the other Federal agencies formulate their science and technology policies, and provides guidance for setting Federal research and development funding priorities. OSTP has a unique opportunity to take a broad and long-term view of Federal science and technology policy.

The Administration and the Congress cannot make sound science and technology policy decisions without wise and dependable advice from the experts. The nominees we will hear from today have experience and background that make them uniquely qualified to advise the President and Congress on issues that are becoming increasingly important to the nation. I look forward to working with and learning from Dr. Phillips and Dr. Wong.

United States Senate

COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

WASHINGTON, DC 20510-6125

STATEMENT FOR COMPLETION BY PRESIDENTIAL NOMINEES

7. Employment record — List all positions held since college, including the title or description of job, name of employer, location of work, and dates of inclusive employment.

From	To	Name of employer	Address	Type of work
4/87	Present	Governor John Ashcroft of Missouri	Jefferson City, MO	Science Advisor to the Governor
4/89	1/90	Missouri Advanced Technology Institute	St. Louis, MO	President
1/87	Present	Mallinckrodt, Inc.	St. Louis, MO	Consultant on Science and Technology
7/84	10/87	Mallinckrodt, Inc.	St. Louis, MO	Senior Vice President of Science & Technology
9/78	6/84	Washington University	St. Louis, MO	Chairman Department of Chemistry
7/51	3/78	E. I. DuPont de Nemours & Co.	Wilmington, DE	A variety of positions a scientist & research director

8. Government experience — List any experience in or direct association with Federal, State, or local governments, including any advisory, consultative, honorary or other part-time service or positions.

a. Science Advisor to Governor John Ashcroft of Missouri (1987-present)

b. Appointed as a director of the Missouri Corporation for Science and Technology by Governor Ash Bond in 1989. This position and that of Science Advisor to Governor Ashcroft will be resigned as of Senate confirmation.

c. Member of the Advisory Board of the Chemistry Division of NSF (1982-85)

9. Political affiliations activities — List all memberships and offices held in or financial contributions and services rendered to all political parties or election committees during the last 10 years.

I consider myself to be a political independent. For many years, including the past two, I have contributed money (with individual contributions never exceeding those to candidates of my choice in both the Democratic and Republican parties, never from working and the above indicated campaign contributions, I have never served any political party or election committee either as officer or volunteer nor have I ever permitted my name to be used in endorsement of any political candidate or political party.

10. Memberships. List all memberships and offices held in professional, fraternal, scholarly, civic, charitable, and other organizations.

Board Directorships:

Mallinckrodt, Inc. 1980-1982
Sigma-Aldrich 1982-1984
Missouri Corporation for Science and Technology 1983-
Atlanta University Board of Trustees 1985-1988
St. Louis Science Center 1985-
St. Louis Technology Center 1985-

Editorial Boards:

Biochemical & Biophysical Research Communications, Editor 1970-88
Biochemistry 1968-1972
Magnetic Resonance 1969-1972
Macromolecules 1970-1972
Inorganic Biochemistry 1970-1972
Analytical Biochemistry 1982-1986
Journal of Biomolecular Structure and Dynamics 1983-

Advisory Committees:

UCSD, Chemistry Department 1968-1978
MIT, Department of Biology 1970-1972
Princeton University, Department of Chemistry 1967-1971
Argonne National Laboratory, Department of Chemistry 1966-1969
National Magnet Laboratory, MIT 1980-1984
Stanford Synchrotron Radiation Laboratory Science Policy Board 1981-1984
Carnegie Mellon University, Department of Biology 1980-1984
NSF Division of Chemistry 1984-1987
NRC Commission on Physical Sciences, Mathematics and Resources 1985-1988

Professional Society Memberships:

American Chemical Society
American Physical Society
American Society of Biological Chemists
Biophysical Society
FASEB
AAAS
Society of Magnetic Resonance in Medicine
Society of Chemical Industry

11. Honors and Awards. List all scholarships, fellowships, honorary degrees, honorary society memberships and any other special recognitions for outstanding service or achievement.

Member of the National Academy of Sciences

Member of the American Academy of Arts and Sciences

WILLIAM D. PHILLIPS

RESPONSES TO SENATOR HOLLINGS' PRE-HEARING QUESTIONS

1. If confirmed as an Associate Director of the Office of Science and Technology Policy (OSTP), what will be your principal responsibilities and activities?

Answer: If confirmed, I will serve as Associate Director for Industrial Technology under Dr. D. Allan Bromley, the Director of the Office of Science and Technology Policy (OSTP). The position of Associate Director for Industrial Technology is new in OSTP and reflects the importance President Bush and Dr. Bromley attach to technology and its use in industry and the desires of the President and of Dr. Bromley that this Administration receives the best possible advice in this crucial area of national concern. In addition, the President has requested that "OSTP play a central role in developing and coordinating Federal science and technology policies, and in analyzing crosscutting issues in research and development." Since virtually every facet of government affects industrial technology development and commercialization, I expect to work closely with all my colleagues in OSTP as well as with the Congress and other agencies of the Federal Government on science and technology policy and funding.

2. What do you see as the nation's principal issues and needs regarding industrial competitiveness, and what role do you see OSTP playing in the creation and implementation of federal policies regarding these issues? If confirmed, what will be your two or three highest priorities?

Answer: The question of U.S. industrial competitiveness and how to improve it is multifaceted and without facile, short-term solutions. Some of our problems are historical in nature and derive from the fact that the U.S. simply does not occupy the unique economic niche that it had for almost three decades following World War II. Through dedicated national effort, some countries have equalled us in certain areas of technology and manufacturing, while in some, few others they have even moved ahead of us. In my view, it's unrealistic to think that within the foreseeable future we will reachieve the overall dominant position in manufacturing that we once enjoyed. However, we are not without impressive resources so that I am equally convinced that very substantial improvements in our competitive posture can be achieved. In order to accomplish these improvements, we must do a better job of translating the world's science and research results, including most prominently our own, into products and services: we must improve the regulatory and financial climate to

that very substantial improvements in our competitive posture can be achieved. In order to accomplish these improvements, we must do a better job of translating the world's science and research results, including most prominently our own, into products and services; we must improve the regulatory and financial climate to encourage patient investment in R&D and capital construction by industry; we in the Federal government must work with industry to encourage and catalyze consortia and joint ventures that will develop the instruments and process parameters that characterize generic technology; we must learn how to facilitate the transfer of technology from our Federal laboratories to industry, and, finally, we must spare no effort in enhancing the skills and comprehension of science and mathematics throughout our entire population. I believe that OSTP and the Industrial Technology Directorate have a major role to play in all these areas.

If confirmed, my initial agenda will include: (a) development of a Technology Policy, (b) working with Dr. Wong, other R&D agency personnel and a committee from the private and public sectors to identify critical technologies and (c) working with Federal Laboratories and their parent agencies on ways to optimize technology transfer to the private sector. Dr. Bromley and I concur with the conclusions of a recent National Research Council study on Materials Science and Engineering that the area of advanced materials is crucial to maintenance and improvement of the U.S. position in industrial competitiveness. The advanced materials area will be of high priority for OSTP and for myself.

3. What size staff do you anticipate will report to you, and how will they be organized? For example, how many Assistant Directors and professional staff would report to you, and what would be their principal functions?

Answer: It is the intent of Dr. Bromley that the activities of OSTP will be conducted in highly collegial fashion. Each of the four division of OSTP, each headed by an Associate Director, will consist of from five to seven individuals. I myself expect to be directly involved in all activities of the Division of Industrial Technology. In addition, we envision one and possibly two Assistant Directors in such areas as technology policy, critical technologies, advanced materials and technology transfer. We will need two program analysts and an office support staff.

4. I am very pleased to see that President Bush's Fiscal Year (FY) 1991 budget request explicitly mentions advanced technology development and stresses the contribution that

research and development (R&D) can make to economic competitiveness and growth. However, it appears that very little of the $71 billion that the President is requesting for R&D actually could focus primarily on building a technology base helpful to general civilian U.S. industry. What percentage of the advanced technology development budget items listed on page 85 of the President's budget request is devoted primarily to assisting commercial industry, and what percentage is devoted primarily to helping agencies achieve agency missions? In your judgment, what percentage of the federal R&D budget in future years should be devoted explicitly to building a technology base helpful to U.S. industry?

Answer: It is not possible to estimate, with any degree of confidence, how much of the budget items on page 85 of the President's budget request is devoted primarily to assisting commercial industry. As you know, most of Federal R&D is mission oriented, and yet, using that approach over the past 40 years, we have created the largest science and technology base in the world. I believe that results from the fact that one-third of total Federally funded R&D supports basic and applied research. Research results, both defense and civilian, have broad applications and tend to diffuse rather quickly. The private sector, however, tends to underinvest in such research because it is difficult for a single firm to realize exclusive benefits from these investments. That is the reason why government has invested so heavily in research. Assuming continuing peace and cooperation with our former adversaries, defense engineering, test, and evaluation associated with large weapon systems will decrease, so that total basic and applied research will become a larger percentage of the Federal R&D budget.

This policy of stressing the need for Federal support of research, including generic applied research, has served the country well during the past 45 years. I believe, however, that when the Federal Government has ventured into trying to support civilian product development its record has been poor, primarily because the government has not understood the market or the user. I would need to know a great deal more about research oriented toward building technology base than I do now to be able to estimate an appropriate level of Federal support.

5. In your recent speech on Missouri high technology initiatives, you make an important point about the strengths and weaknesses of American science and technology. You say,

"again, our problem is not in our science, which remains the best in the world, but in the translation of the research results of our laboratories into competitive commercial products." As someone with extensive experience in both research and industry, what do you think are the primary reasons for this problem of translating discoveries into successful products? Why do Americans so often seem to lag in this regard compared to our trading partners? Also, why do you think that some American industries have been more successful in developing new products and exports than others? For example, are there particular reasons why the chemical industry in this country has been so successful as compared with some other sectors?

Answer: Let me begin to answer this series of questions by addressing why, in my view, the U.S. chemical industry, though challenged, has maintained its competitiveness and, indeed, contributes a positive $16 billion annually as partial offset to our overall negative trade balance. The reasons are many. The world markets for chemicals have long been global in nature. As a matter of fact, the U.S. chemical industry reached its present position of preeminence by taking market share away from Germany and Great Britain. The chemical industry has always been technology intensive and technology driven. As a result, there long has been a tight coupling between U.S. chemical companies with research universities for purposes of faculty consultation and recruitment of chemists and engineers. Chemical companies have been generous in fellowship and grant support to universities which has, in turn, been conducive to attracting some of our best young talent into chemistry and chemical engineering. By necessity, the chemical industry, because of the potentially hazardous nature of their starting materials and intermediates in the manufacturing process, and the need for cost minimization, have always paid a great deal of attention to process chemistry, automation and product quality. The chemical industry has traditionally stayed attuned to the needs of its customers. As already alluded to, the chemical industry is and has been technology driven. In every chemical company, scientists and engineers are ubiquitously distributed throughout the organization, not only in R&D but in manufacturing, marketing, and sales. And scientists and engineers are found in all levels of management of chemical companies. The thrust of the chemical industry has been the discovery, through synthesis, of new molecules or modification of existing molecular entities that lead to desirable product end use. The composition of matter patents obtainable on such materials afford strong

protection and incentive for capital investment and commercialization. Finally, a strength of U.S. chemical companies has been their willingness and ability to either abandon or de-emphasize particular markets, e.g., commodity chemicals, and to move into areas of higher value-in-use, e.g., pharmaceuticals, biotechnology, advanced materials for the electronics and information markets. The absence of one or more of the above characteristics frequently has led to sluggishness in responding to competition or to altered market conditions in some of our industries.

In addition to the above, it must be borne in mind that changes have occurred over the past decade that have made it extremely difficult for some of our industries to remain competitive in technology development and manufacturing. One example is our microelectronic industry and a developing trouble area may be in biotechnology. R&D, development of manufacturing processes and capital investment in plants have become so expensive in, for example, the microelectronics industry, that individual U.S. companies simply do not possess the resources to respond in timely fashion to global challenges from companies such as those of Japan that play by different rules and that can operate in macroeconomic environments more favorable to long-term investment in R&D and modern manufacturing facilities.

6. In general, what do you believe is the appropriate federal role in developing advanced technology? In particular, what do you think is the appropriate role of federal research agencies in working both with state governments and with businesses to help strengthen our nation's technology base?

Answer: In the development of advanced technology, it is essential that the Federal government continue support for basic science and engineering in our research universities. Not only is the new information being generated by this support essential to development of advanced technology products by our industry, but the scientists and engineers being trained in our university laboratories are required for positions in our industrial and government laboratories and on our university faculties. DARPA has played an invaluable role in the past in catalyzing the generation of new dual-use technologies and I see no reason to believe that the need for this activity will be lessened in the future. The activities of NIST in the advanced manufacturing area require strengthening, as do those in the area of plant biotechnology by the Department of Agriculture. We need to remove impediments and enhance motivation to optimize technology

transfer from Federal laboratories. Finally, there is a tendency for federal programs in assistance and technology to be decoupled from state programs. The Federal government must become more aware of, and must consider, state agendas and initiatives as it develops its own programs. Federal funds can be highly leveraged by consortia and other forms of partnerships involving states and industry.

7. The 1988 Omnibus Trade and Competitiveness Act assigns major new responsibilities to what is now the National Institute of Standards and Technology (NIST), the statue also retains NIST's important traditional measurement and standards functions. Do you believe that NIST has made, and can continue to make, important contributions to industrial technology? Do you expect to play a role in working with Dr. Bromley, other offices in the Executive Office of the President, and the Department of Commerce to shape the priorities and programs of NIST? What role would you personally like to see NIST's laboratory, technology extension and advanced technology programs play in the years to come?

Answer: For years NIST, formerly called the National Bureau of Standards, has performed a unique function in the area of standards and measurements; we should not now allow new activities to interfere with, or diminish, that role. If confirmed, I plan to work closely with Deputy Secretary Murrin of the Commerce Department and Director Lyons of NIST to assist in defining any new role for NIST. Certainly, whatever NIST does in the area of technology extension will have to be carefully defined and should be coordinated with state programs because many states are already very active in working with their industries at both the state and local levels. In any scenario, NIST and the Department of Commerce should play major and key roles in our thrust toward increased competitiveness.

8. During the Reagan years, officials at the Department of Defense (DOD) stressed that a strong overall national industrial base is necessary if the military is to have American sources of advanced technology. As a result, they stressed the importance of dual-use technology and of the research that creates that technology. This policy placed great emphasis on the research programs of the Defense Advanced Research Projects Agency (DARPA). Do you agree that it is in the interest of both DOD and the economy as a whole for DARPA to continue to support important areas such

as electronics and advanced materials? What do you think is the appropriate balance between DOD and civilian research agencies, such as NIST, in helping build the nation's overall technology base?

Answer: In many areas, with the exception of specific weapon systems requirements, technologies that are critical to the military are also important to American industry. The growth of the civilian aircraft and microelectronics industries can certainly be traced to defense R&D. DARPA's primary motivation is to support the military mission, and DARPA will continue to do so. The fact that some of the technologies being developed by DARPA have civilian applications is an indication that civilian and military technologies are not very far apart when it comes to fundamentals. DARPA needs to continue what it is doing, and in that sense it serves as a model.

The premise of the question seems to be that our overall technology base is inadequate. I would suggest that the technology base is not all that inadequate but that we need to learn to make better use of it. The role of government agencies in addressing that problem is something that I and my colleagues at OSTP intend to examine carefully in the immediate future.

9. The Commerce Department's General Counsel, Wendell Willkie, recently sent a letter to Congress commenting on pending authorization legislation for Commerce Department technology programs. One part of the letter deals with the question of whether and when foreign-owned companies should be allowed to participate in government-assisted research consortia. While Congress and DOD have agreed that no foreign firms should participate in SEMATECH, Mr. Willkie argues that it would be discriminatory to bar foreign companies from any Commerce Department-assisted research projects. I do not personally agree with this position, but I would like to ask you what the Administration's overall position is regarding foreign access to taxpayer-supported domestic research programs. Is it now the Administration's position that because the government's international policy calls for free and open trade, it then follows that all domestic research programs must be equally open to foreign and American citizens? For example, does the Administration believe that foreign nationals should have equal access to National Science foundation (NSF) graduate fellowships and that it is "discriminatory" to reserve those fellowships for U.S. citizens? Are researchers in Japan and Europe now to be

treated equally with American citizens in competitions for federal research grants? In general, what is the rationale for saying that in the case of domestic research programs, Congress should not use taxpayer collars to advanced U.S. interests and to promote the interest of U.S. citizens?

Answer: I do not know anything about the issue or authorization legislation referred to in your question. But I can say that the short answer to your question is that there is no rationale "for saying that in the case of domestic research programs, Congress should not use taxpayer dollars to advance U.S. interests and to promote the interests of U.S. citizens." What do I believe is the purpose of NSF graduate fellowships? They are to provide partial support of superior U.S. graduate students who are carrying out research under the supervision of a qualified faculty member at a U.S. university. I know of no one who is seriously proposing that scientists and engineers in Japan and Europe be given access either to NSF graduate fellowships or to federal research grants.

However, if the issue being addressed was the help and support the Department of Commerce supplies to U.S. industries, then for a foreign owned firm based wholly in the U.S. and conducting business here (R&D, manufacturing), I see no grounds for denying access to those programs whose mission is to assist all such firms, irrespective of ownership. The issue of transnational companies makes it very difficult to differentially apply the benefits of such programs.

10. Recently, some Members of Congress have proposed the creation of an Advanced Civilian Technology AGency (ACTA) in the Department of Commerce (DOC). Sometimes this proposed new agency is referred to as a "civilian DARPA." Do you and Dr. Bromley favor the creation of such an entity? Or do you feel that the existing authorities and organization at the Commerce Department are sufficient and appropriate?

Answer: DARPA worked and continues to work because its mission and objectives were, and are, clearly defined, namely, to encourage and finance development of new technologies that have been essential to maintenance of our defense posture. In this endeavor, it has been extremely successful. As so often occurs in the development of generic technologies, it is difficult to forecast products and systems that may derive from the technologies developed. In the case of the DARPA investments, there has been a remarkable stream of spin-offs that have made

their way into the private sector. These include computer time sharing, computer graphics, multiprocessors and artificial intelligence. For a "civilian DARPA," no comparable goals and mission have been defined nor would they be easy to define. Until criteria can be developed, in my opinion, judgment must be reserved on justification of a "civilian DARPA." One thing that must be avoided is creation of another federal agency that is not enthusiastically endorsed by industry as having the potential of contributing effectively to solution of our competitiveness problems.

11. In recent years corporations have contributed increasing amounts of money to university research programs. The federal government has generally encouraged this trend, both by allowing universities to keep the patent rights to federally funded inventions and through the creation of industry-university projects such as NSF's engineering research centers. During the early 1980's, some professors expressed concern that increasing corporate investment could either create additional secrecy and thereby interfere with free and open communication or else divert faculty from teaching and other traditional university functions. Washington University, where you taught for some years, has been a pioneer in developing new collaborative research ventures with American companies. In your judgment, what have been the results of these collaborations? Have they benefitted both the universities and the companies? Can you suggest any guidelines that help reduce problems in the ventures?

Answer: Concerns expressed by some faculty at the beginning of the substantial partnerships initiated between research universities and companies in the early 1980's have been almost totally unfounded. The companies involved, by and large, displayed understanding of-and sensitivity to-the multiple roles of universities, and agreements were worked out that amply protected the rights and needs of the university, faculty and students in such areas as royalties, publication rights, patents and the training of students. In turn, the companies gained access to cutting edge research, often carried out collaboratively between faculty and corporate scientists, that has led to a series of commercializable products. All parties, including the nation, have profited. In my view, the universities that have participated in this process have been improved with respect to traditional goals and functions. The

federal government should encourage such efforts and, where appropriate, leverage its funds through joint ventures.

12. Increasingly, both environmentalists and businessmen see advanced technology as an important factor which can help reduce our nation's pollution problems. What role do you think federal R&D programs can play in helping to develop innovative technologies that aid both economic growth and protection of the environment? Do you believe that OSTP can play a constructive role in this issue?

Answer: In my view, concern for the environment and good manufacturing practice are by no means incompatible. Just as industry is realizing that building quality into manufacturing processes can lead to lower manufacturing costs and to increased customer and worker satisfaction, I am equally convinced that building valid environmental concerns into manufacturing and other industrial processes will ultimately lead to enhanced U.S. competitiveness. Federal R&D programs in concert with industry and universities can play a major role in this process. Much R&D remains to be done in the atmospheric and ocean sciences, in epidemiology, in risk assessment, in the earth and botanical sciences. I would suggest that instead of confronting the problem of hazardous waste disposal at the end of a manufacturing process, the private sector that would be competitive must make a top priority the nullification of hazardous substances generated during the manufacturing process or, if appropriate, converting such wastes to useful intermediates or products. The emphasis here, as with final product quality, must be inclusion of environmental factors as primary design criteria into manufacturing processes from the outset and not as an afterthought. This can only be done, however, under conditions of enlightened, rational and predictable state, national and international regulations governing the environment and its integrity. I believe that OSTP with its broad charge can and should play a major role in bringing about clear Federal policies to deal with this evolving problem.

13. In 1986, Congress and the Reagan Administration worked together to enact the Federal Technology Transfer Act, a statute which permits and allows federal laboratories to enter into cooperative research agreements with industry, the states, universities, and others. Last year, new legislation extended this authority to Department of Energy weapons laboratories, one set of federal facilities not originally covered by the 1986 Act. In your judgment, how

has this Act worked in practice? Do you believe that Federal laboratories can and have begun to transfer unclassified federal technology to the private sector? Do you think that the mission laboratories of federal agencies can make important contributions to improving American industrial competitiveness?

Answer: It is my understanding that many initiatives directed towards the transfer of technology from federal laboratories to industry are underway as the result of the Federal Technology Transfer Act of 1986. Studies are in progress as to how to bring the DOE weapons laboratories into this activity. There is no question but that transfer of unclassified federal technology to the private sector has begun. Is the rate of such transfer satisfactory? Probably not. Are all the appropriate mechanisms, e.g., incentives, information basis, dedicated champions in place? Almost certainly not.

It must be borne in mind, however, that technology transfer is a very difficult and delicate thing, even when it involves intracompany transfer between a corporate research department and an operating division of a company. At the present time, it is too early to tell to what extent the federal laboratories can be employed to bolster the competitiveness of U.S. industry, particularly if cost effectiveness is employed as one criterion of success. In some instances, e.g., NIH, the transfer will be more straightforward than in others simply because of the nature of the research products and their utility to industry. Over the next few years, we must do everything possible to optimize the extent to which this formidable resource can be utilized in enhancing our industrial base and in improving our competitiveness. I am told that Secretary Watkins has initiated a major study to determine how the important DOE laboratories can more effectively participate in technology transfer. I certainly want to assist the DOE in any way that they think appropriate to expedite putting in place those mechanisms that will ensure that the DOE can contribute to this national effort.

14a. In 1988, President Reagan and the Prime Minister of Japan signed a new United States-Japan Science and Technology Agreement. The new agreement established a comprehensive set of guidelines for both cooperative research projects between the two countries and other forms of cooperation, including exchange programs. What role is OSTP now playing

in federal decisions regarding possible projects under this new agreement?

Answer: It is my understanding that through his chairmanship of the Federal Coordinating Council for Science, Engineering and Technology, and as Co-chairman of the U.S.-Japan Joint High Level Committee, the Director of OSTP has played an active role in decisions regarding possible new cooperation under the U.S.-Japan S&T Agreement. To provide the best coverage of the agreement and to ensure all agencies have an opportunity to participate under the Agreement, the FCCSET committee structure has been used to develop bilateral project proposals. The United States and Japan exchanged over 60 proposals in April of 1989 at the a meeting of the Joint Working Level Committee. Those project proposals were developed and reviewed by FCCSET under OSTP guidance, and reevaluating the April proposals and making an attempt to streamline the number of proposals and group them into research fields in which the United States has a particular interest in cooperation with Japan. These will be discussed with the Japanese at the next Joint High Level Committee meeting tentatively scheduled for May 4, 1990.

14b. What priorities do you believe the federal government should stress in its proposals to the Japanese, and what forms of U.S.-Japanese cooperation do you think would be in the best interest of the United States?

Answer: I have been told that OSTP has stressed five criteria to be used by the FCCSET's as they develop project proposals. These are:

- -- that both countries bring a record of solid achievement to the cooperation;
- -- that both countries have a demonstrated need for new knowledge and progress in the selected area;
- -- that there be a realistic expectation of concrete results from the cooperation within 18 to 24 months, so that initial interest and momentum can be maintained;
- -- that the areas be generally perceived as sufficiently important, at both the national and international levels, to merit head-of-government attention; and
- -- that there is a clearly stated U.S. industry interest in cooperation with the Japanese in the selected field.

I believe that the best forms of cooperation are those that meet these criteria. Most importantly, OSTP is attempting to ensure that project proposals are in areas that interest U.S. industry and in which U.S. industry stands to participate in and benefit from the cooperation. Secondly, the Agreement is designed to redress the imbalance of the current cooperation between the United States and Japan, with far more Japanese researchers visiting the United States than U.S. researchers doing work in Japan. I believe that we should--and I have been told that we do--focus on programs of research that would encourage more U.S. researchers to go to Japan to work in academic, federal and industrial laboratories.

15. Many of us in Congress now find that in order to set the science and technology policies of our country, we must better understand what programs are being undertaken in other major countries, including Japan and the members of the European community. This is placed increasing importance on programs which monitor and analyze foreign technological developments. Current programs in this area include the JTECH Program, which is overseen by NSF, and the Japanese Technical Literature Program at the Department of Commerce. Many other federal agencies also collect information on scientific and technological developments abroad. In your judgment, are current federal efforts to monitor and understand foreign technological developments sufficiently coordinated and sufficiently linked to R&D policymaking? Do you expect OSTP to be active in setting federal policy regarding technological monitoring, and, if so, what particular role do you expect the Office to play?

Answer: As you point out, there are a number of programs in various Federal agencies that are dedicated to monitoring science and technology programs and advances in Japan and in the EC. In addition, our scientists and engineers in university, industry and government laboratories closely monitor technical advances published in the literature and presented at conferences. Many U.S. companies routinely monitor technology advances abroad through their foreign subsidiaries and through visits to foreign companies and universities. A multiplicity of information gathering mechanisms thus exist. The agencies involved appear sensitive to the need to continually improve intelligence gathering and to the need to get the information into the hands of policy makers. OSTP, as an agency, is, I have been told, equally sensitive to these needs and will continue to work with pertinent agencies to that end.

16. Currently, the Administration is working with our NATO allies and Japan to review export control rules which govern the sale of high-technology products to Eastern Europe, the Soviet Union, and other communist countries. Export control policy, however, remains a difficult area, with a continuing need to balance the economic interests of our industries with the need to keep sensitive technology out of the hands of potential adversaries. If confirmed, do you expect to play any role in the Administration review of export control policy. And, if so, what issues do you believe need to be considered during this review?

Answer: OSTP and I, personally, as Associate Director for Industrial Technology, if confirmed, expect to play a role in analysis and recommendations with regard to export control policy and rules. A major past and continuing factor in export control policy for ourselves and our allies has been the need to restrict access to sensitive technology to potential adversaries. Against this must be balanced the fact that the marketplace is of an increasingly global nature. It could even be argued that the thrust toward globalization of markets is a strong impetus toward solution by peaceful means of problems between nations. As the world political situation evolves toward a less confrontational stance between the Allied and Soviet Blocs, export control policy requires updating. In my view such updating will inevitably result in greater flow between all countries of what are today considered high technology products. This means that export controls will require careful scrutiny to ensure that the U.S. can remain competitive with our allies in the global marketplace while, at the same time, ensuring that we retain our national security edge over potential adversaries.

STATEMENT OF DR. WILLIAM D. PHILLIPS

Dr. PHILLIPS. Thank you, Mr. Chairman, and thank you, Senator Danforth, for that very kind introduction.

I am not going to elaborate on that very much except to begin by indicating that my particular area, as you pointed out, Mr. Chairman, will be in the area of industrial technology. I think it is a crucial area to our country. I think a definition of industrial technology might go along the lines of the translation of the results of science and engineering, whether they are generated in industrial laboratories, academic laboratories or Federal laboratories, into timely, cost-competitive, quality products.

Now this is a narrow definition. I say narrow because this seems to imply that our entire problem is in the translation of scientific engineering results into products. It is not. I feel that we have a much broader problem. Part of this involves residual adversarial relationships that exist between the Federal government and between our industries. Part involves residual adversarial relationships that exist between labor and management.

In addition, I think that part of the problem resides in the economic climate in which we presently operate. In view of the high cost of capital in the U.S., there is a reluctance on the part of industry to invest in the expensive R&D and in the expensive plant that is required to enhance our worldwide industrial competitiveness.

If confirmed, my particular area of responsibility will be in the area of Industrial Technology. The importance of Industrial Technology as a component of the analysis and advice essential to the President is keenly appreciated by Dr. Bromley. He has been anxious to fill the position of Associate Director for Industrial Technology. Irrespective of who ultimately occupies the position, I agree wholeheartedly with the need. I don't intend to recite here the by now familiar litany of problems that confront the manufacturing sector of our economy; this Committee is well aware of them. However, it is imperative that we properly analyze these problems and accelerate remedial action. A narrow definition of industrial technology is translation of scientific knowledge, whether generated in research universities or federal or industrial laboratories, into timely, cost competitive, quality services and products, while bearing in mind that the markets for these services and products are global and not national. I refer to the above as a narrow definition because it implies that our problems in competitiveness reside entirely in the areas of manufacturing and process. Unfortunately they don't. We have developed structural problems that are not going to be easily resolved. These include the residual adversarial relationships that exist between government and industry and between labor and industrial management; the relatively inadequate math, science and language skills of a sizable portion of our work force; the investment climate in the U.S. which is inhibitory to the long-term R&D and capital investment programs essential to global competitiveness. Solutions to our problems in competitiveness must encompass actions on many fronts and must involve all components of our society. OSTP, under the direction of Dr. Bromley, has

an important role to play in this endeavor. If confirmed, I look forward to participating in this important enterprise.

Senator GORE. Very good.

Dr. Wong, welcome. Please proceed with any comments you have.

[The biographical sketch and prehearing questions and answers follow:]

United States Senate

COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

WASHINGTON, DC 20510-6125

STATEMENT FOR COMPLETION BY PRESIDENTIAL NOMINEES

(If more space is needed, please so indicate and attach REMARKS sheet)

A. BIOGRAPHICAL DATA

1. Name: WONG (Last) EUGENE (First) (Middle)

Address: 97 Stonewall Road (Number, Street) Department of Electrical Engineering and Computer Sciences (Business)

Berkeley, California 94705 (City, State, Zip) University of California Berkeley, California 94720

2. Position to which nominated: Associate Director for Physical Sciences & Engineering Office of Science & Technology Policy

Date of nomination: 1/23/90

3. Date of birth: 12 (month) 24 (day) 34 (year) Place of birth: Nanking, China Citizenship: U.S. (naturalized 9/18/55)

4. Marital status: Married Full name of Spouse: Joan Chang Wong

5. Names and ages of children: Linda W. Verheecke (31)
David J. Wong (23)
Michael E. Wong (19)

6. Education

Institution	Dates attended	Degree received	Date of degree
Princeton University	9/52 - 6/55	B.E.	6/55
	9/56 - 6/59	A.M.	6/58
		Ph.D.	6/59

7. Employment record. List all positions held since college, including the title or description of job, name of employer, location of work, and dates of inclusive employment.

From	To	Name of employer	Address	Type of work
6/55	8/56	IBM	Poughkeepsie, NY	Jr. Engineer - Research
9/59	7/60	National Science Foundation	U. of Cambridge (Cambridge, England)	Postdoctoral Fellow
7/60	7/62	IBM	Yorktown Heights, NY	Member, Research Staff
7/62	Present	University of California	Berkeley, CA	Assistant Professor (1961-65)
				Associate Professor (1965-69)
				Professor (1969 - Present)
				Chairman, Department of Electrical Engineering & Computer Sciences (1965-89)

9. Government experience. List any experience in or direct association with Federal, State, or local governments, including any advisory, consultative, honorary or other part-time service or positions.

National Science Foundation, Postdoctoral Fellow, 1959-60

9. Political affiliations activities. List all memberships and offices held in or financial contributions and services rendered to all political parties or election committees during the last 10 years.

Contributed $125 to Republican Party in 1989

10. Memberships. List all memberships and offices held in professional, fraternal, scholarly, civic, charitable, and other organizations.

Institute of Electrical and Electronic Engineers

Association of Computing Machinery

National Academy of Engineering

11. Honors and awards. List all scholarships, fellowships, honorary degrees, honorary society memberships, and any other special recognitions for outstanding service or achievement.

National Science Foundation, Postdoctoral Fellow	1959-60
Guggenheim Fellow	1968-69
Vinton Hayes Senior Fellow - Harvard University	1976-77
Miller Professor - University of California, Berkeley	1983-84
Fellow, Institute of Electrical and Electronic Engineers	(1974)
Member, National Academy of Engineering	(1987)

RESPONSES TO CHAIRMAN HOLLINGS'S PRE-HEARING QUESTIONS
FROM DR. EUGENE WONG
PRIOR TO CONFIRMATION HEARING BEFORE THE
COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY AND SPACE
UNITED STATES SENATE
FEBRUARY 28, 1990 - WASHINGTON, D.C.

Question 1. If confirmed as an Associate Director of the Office of Science and Technology Policy (OSTP), what will be your principal responsibilities and activities? Will you be particularly responsible for federal research and development (R&D) programs in the physical sciences and engineering? If so, will you be Dr. Bromley's principal deputy for such areas as basic research, defense, space and energy?

Response to Question 1. If I am confirmed, my principal duties will be to help in formulating national policies and coordinating federal activities in physical sciences and engineering. I expect to be Dr. Bromley's principal deputy for basic research in defense, space and energy.

Question 2. What do you see as the nation's principal policy issues in the areas that you will work on, and what role do you see OSTP playing in the creation and implementation of federal policies regarding these issues? If confirmed, what would be your two or three highest priorities?

Response to Question 2. I have three goals that transcend all others: (a) to maintain our strength in basic research and advanced development; (b) to maximize the benefits of these activities to our economic growth; and (c) to strengthen our system of higher education in science and engineering, and to ensure access to science and technology for all our citizens, especially those who are currently under-represented.

Question 3. What size staff do you anticipate having, and how will they be organized? For example, how many assistant directors and professional staff would report to you, and what would be their principal functions?

Response to Question 3. In the immediate future, I expect to have a staff of four: an assistant director and a policy analyst (both detailed from the National Science Foundation); an SAE (Society of Automotive Engineers) Fellow; and an administrative assistant. I hope another professional can be added later in fiscal year 1990. I would like my group to function as a team, without clearly defined and distinct areas of responsibility, while utilizing the special expertise of the individuals. For example, Dr. Karl Erb, Assistant Director for Physical Sciences, is a nuclear physicist and would have a special responsibility on issues pertaining to SSC.

Question 4. Both the President and Congress have proposed doubling the budget of the National Science Foundation (NSF) over a 5 year period. What benefits do you believe that basic university research and the associated training of new scientists and engineers provide to this country? What strengths and weaknesses do you see in the nation's current university research system, and do you believe that current federal policies in both NSF and other research agencies are doing enough to maintain the quality and strength of our nation's universities?

Response to Question 4. Basic university research and the associated student training have been vital to the intellectual and economic health of the nation, and their importance is greater than ever. The proposed budget increase for the National Science Foundation comes at a time of decreased funding for basic research by American industry and declining interest in graduate study in engineering and physical sciences. Federal funding for basic research should be increased, as proposed by President Bush in his FY 1991 budget. I should also point out that

innovative programs are needed to attract a larger number of students into these disciplines.

Question 5. As you know, Congress and the Administration are now engaged in discussions over how much, and in what ways to reduce the defense budget of the United States. One issue in these discussions is the role and the need for future defense R&D. Some argue that defense research can safely be cut, along with other parts of the defense budget, because of the reduced threat of confrontation with the Soviet Union. Others argue, however, that with smaller forces and more uncertain threats the United States needs to maintain its defense research efforts in order to ensure a continued technological edge. Complicating the issue further is the question of what role the Department of Defense (DOD) should play in helping to develop dual-use technologies in an era where the military increasingly must rely on the technological capabilities of commercial industry. What are your views regarding the long-term role and appropriate size of the defense research budget? If confirmed, do you expect to play a role in helping Dr. Bromley and other senior Administration officials analyze these questions and formulate recommendations for the President?

Response to Question 5. In my view, the research portion of the defense budget should be maintained or even increased. That portion devoted to development, test and evaluation is driven by demands of specific new weapons systems and affect the technological base only indirectly. Much of defense research is indeed of dual use, and the DOD infrastructure for supporting research is irreplaceable in the near future. DARPA is a prime example in this regard. However, the changing world situation will indeed affect DOD's role in the overall federal R&D program. A broader use of its infrastructure, for example, may be appropriate. I hope that I shall have a useful voice in formulating recommendations to take full advantage of the opportunities provided by changing defense needs.

Question 6. Congress now faces a growing number of major space projects that could help the country, but which collectively would be enormously expensive. For example, there are now proposals for the space station Freedom, the Mission to Planet Earth and its associated Earth Observing System satellites, and now the President's proposed Moon/Mars Mission. If confirmed, what role do you expect that OSTP will play in working with the Space Council and with the National Aeronautics and Space Administration (NASA) in setting priorities for our nation's space program and ensuring that NASA will have the required basic technological capabilities to undertake whichever major missions are chosen?

Response to Question 6. Dr. Bromley is a member of the Space Council, and to the extent that staffing allows, OSTP will play a strong part in evaluating the relative scientific merits of proposed space missions.

Question 7. What do you see as the principal needs and priorities that should guide the nation's civilian energy R&D effort? For example, how should the government's growing sensitivity to global environmental change help shape the research efforts to develop new energy technologies? What research priorities do you believe the country should follow in such areas as conservation, solar and renewable energy, nuclear power, and fossil fuels?

Response to Question 7. Environmental considerations, economic needs and technological opportunities must be balanced to determine our research priorities in the energy area. Dr. Bromley is working closely with Secretary Watkins in assessing these policy discussions. A series of hearings co-chaired by these two is currently being held.

Question 8. Recent problems in the technology required for the Superconducting SuperCollider (SSC) have raised new questions about the final cost of this major facility. How much does OSTP now calculate that the SSC will cost if its original design specifications are kept? Also, have problems with the magnet technology also led OSTP to revise the schedule for completing this project? Finally, have the escalating costs led the Administration to reconsider the project or to give new

consideration to the possibility of building a new jointly funded machine with the Europeans?

Response to Question 8. I understand that Secretary Watkins of DOE is conducting a thorough review of the cost and schedule associated with the proposed changes in the design of SSC, and that Dr. Bromley is in close contact with this review.

Question 9. As you may know, this Committee, and particularly Senator Gore, has long had an interest in high-performance computing. Do you agree with the recommendations for additional spending made in the OSTP reports dealing with high-performance computing? Do you believe that the OSTP proposals, including the proposed National Research and Education Network, can indeed contribute to the capabilities of academic researchers and also help develop innovative new technologies? While the President's FY 1991 budget requests few additional funds for strategic computing, will the Administration consider requesting additional funds in its FY 1992 budget request?

Response to Question 9. I fully agree with the recommendations of the OSTP reports on high performance computing and shall do my best in urging adequate funds in the 1992 budget. As much as money, a coordinated plan is needed, and I hope to play a significant role in formulating such a plan.

Question 10. This country has greatly benefited from the foreign-born scientists and engineers who have studied at American universities and have chosen to remain in this country. However, many Members of Congress also would like to see more native-born Americans choose to pursue doctoral studies in science and engineering. Members would particularly like to encourage more women and minorities to enter these fields. As a senior professor with long experience in training students, what steps do you believe the federal government can take to help encourage a wide range of American students to pursue careers in science and engineering? If confirmed, do you expect that you will be involved in Administration reviews of this issue?

Response to Question 10. In my view, aside from deficiencies of public school education, there are two basic problems: a lack of timely motivation on the part of students, and for many an inadequate level of support and encouragement on a sustained basis. I think both of these problems can be addressed successfully and quickly by well-designed, innovative and carefully executed programs. For example, the problem of not being motivated when opportunities exist can be dealt with in two ways: first, by intervening at points in a student's life critical to career choices, freshman year in college being an example; second, by providing second and third chances to those who may have missed an earlier opportunity. The latter is of particular importance to minority and women students who often need multiple opportunities of access to successfully gain entry into scientific and professional fields. I have had rewarding experiences in such programs, and to help in launching an effective federal effort in these areas will be one of my highest priorities.

Question 11. The United States has long prided itself on the openness of its universities. More recently, however, some observers have begun to wonder whether American universities are in fact training our economic competitors and providing far greater access for foreign companies to acquire our research findings than foreign universities offer to Americans. In your judgment, how can the United States strike an appropriate balance between openness in universities and the need to ensure that taxpayers' dollars are spent on research and training which advance United States' interest?

Response to Question 11. I think any attempt to deny foreign access to our university basic research results would be counterproductive. It probably would not work, and might impede our own research progress instead. However, we should be vigilant in

asserting and protecting our intellectual property rights. The federal government has a major role to play in providing means for such protection.

Question 12. In recent years, American corporations have increased their investment in university research programs. This development has led some faculty members to question whether the introduction of corporate research funds will hurt either the freedom of communication and inquiry or divert faculty attention away from more fundamental research and student training. As chairman of a major engineering department, what effects have you seen from increased corporate interest and investment in university research programs? Do you believe that any changes need to be made in the current relationship between universities and corporations?

Response to Question 12. Increased corporate support of university research has been of great mutual benefit. It allows the companies to leverage their limited R&D resources; it provides much-needed support to universities; and in engineering it has made university research more focused and much more useful. While there are potential problems, all parties are sensitive to them, lest a highly synergistic relationship be damaged. I do not think any governmental intervention is appropriate here.

Question 13. For many years, NSF concentrated on support of scientific research and provided relatively little support for basic research in engineering. In the mid-1980s, Congress added engineering research to the statutory mission of the agency, and the Adminstration requested additional funds for NSF support of engineering. Nonetheless, NSF devotes relatively little funding to many areas of engineering considered important to the country's long-term economic competitiveness, including such areas as manufacturing engineering and key emerging technologies. In your judgment, should NSF and other federal research agencies increase their support for fundamental engineering research? Has the relatively low level of federal support for engineering research been one of the reasons why U.S. manufacturing now appears to lag behind that of other major industrial nations?

Response to Question 13. I think manufacturing deserves a much greater level of attention from all sectors of our society, not merely NSF. These include government agencies, industry, universities, and private foundations. It is one problem that must be fixed, and fixed quickly. In addition to providing more funds, we need to manage our manufacturing research better. Supporting research in a targeted area such as manufacturing requires a process rather different from that used for basic sciences. Here, goals need to be better identified and focused, and programs -- rather than individual projects -- managed, and managed to a successful conclusion.

Question 14. Over the past several years, both Congress and the Administration have received disturbing reports about the adequacy of current research facilities in the nation's universities and colleges. Congress responded to this need by creating a new academic facilities modernization program within NSF. However, in the current tight budget environment, many leaders believe that limited federal research dollars should concentrate on research, training, and instrumentation and that facilities modernization efforts should not be increased at the expense of these other activities. In your judgment, what is the state of current university research facilities in the United States? Are problems with facilities, in fact, beginning to affect the ability of researchers to make progress in their fields, or are the facilities, while not perfect, nonetheless generally adequate? What priority do you believe federal agencies should place on helping universities and colleges to modernize their laboratories and other research facilities?

Response to Question 14. My impression is that the infrastructures are generally still adequate, but deteriorating. Maintaining adequate physical infrastructures is a long-term problem that requires long-range solutions. The $20 million NSF program on facilities is a good beginning, and a comprehensive approach with built-in long-term funding mechanisms should be developed.

STATEMENT OF DR. EUGENE WONG

Dr. WONG. Thank you, Mr. Chairman. It is with some considerably pleasure and no small humility that I appear before you today to seek confirmation in the position of Associate Director in the Office of Science and Technology Policy. I am deeply honored by President Bush's nomination of me to this post, and if confirmed I shall do my very best to serve well.

Over the last 40 years I have enjoyed truly a bounty of opportunities in both education and career choices. Graduating from Princeton in 1955, I spent some years with IBM Research in the very early years of computers. I have enjoyed 28 happy and productive years at Berkeley teaching, doing research and participating in self-governance of the faculty. I have experienced firsthand the joy and the pain of being an entrepreneur, and the truly satisfying rewards of educational innovation.

I think this is truly an important time for science and technology. The importance of science and technology to our national well-being has never been greater, and I think with the commitment of the President, the support of Congress, and the leadership of Dr. Bromley the opportunity for effective policymaking in this area has also never been greater.

I look forward to the opportunity, if confirmed, to participate in this exciting process and I humbly seek your support.

Senator GORE. Thank you very much. We will begin the questioning with Senator Danforth.

Senator DANFORTH. Mr. Chairman, thank you very much.

Dr. Phillips, I would like your general thoughts, anything you care to say, about the point that I made in my introduction of you, and that is the appropriate role or nonrole of academia, government, and industry.

The university with which you have been associated, Washington University, has been, I think, something of a pioneer in this effort, certainly with respect to its relationship with Monsanto in genetic research. Is this a promising thing or a dangerous thing for the country? What comments would you make about it?

Dr. PHILLIPS. Thank you, Senator Danforth, for that particular question because it is one which I feel is of very great importance in the country.

I think we all recognize that we have a magnificent structure in our research universities. It is an enormous resource which we frankly have just begun to tap. And it is interesting to look into the history of that. Prior to World War II, there was rather little in the way of Federal funding for our universities. Most of the research funding came from the States; a significant portion of the research funding actually came from U.S. industry.

Then, after World War II, after the enormous contributions of our research universities to the war effort, it became obvious to the Federal government what an enormous resource the U.S. research universities represented. The Office of Naval Research was the first of our Federal agencies that really seriously began to fund research in universities after 1945. This Federal funding grew as our defense responsibilities increased. It grew as the National Science Foundation and the National Institutes of Health were established.

But in this process the possibility of significant interactions with our industry became underscored, and as a matter of fact there was really relatively little funding by industry of our universities between 1945 and, say, 1975. But then, with the advent of the enormous successes in the basic undertaking of life processes brought on by the Watson-Crick hypothesis, it became evident that there were great potential benefits, particularly in the pharmaceutical, the life sciences area, for mutually beneficial interactions between our universities, research universities and industry.

As you pointed out, Washington University, with their seminal contract that they developed with the Monsanto Company in the early 1980s, has provided a fine model that many other universities and industries have picked up. What the agreement accomplished, basically, was to satisfy the needs and rights of both parties. Washington University protected its basic function and role, which was to train students and to generate research, and the Monsanto Company in turn has access to a number of research leads that may well turn into useful products.

But I would say that there is a great future to these kinds of interactions. I think one needs to keep in mind that the level of funding by industry today in our research universities only amounts to about eight percent. The rest of it comes principally through Federal funding, with lesser contributions from States. I think there could be a danger if the degree of industrial funding ever got to be a major part of the funding. There might then be a conflict between the agendas of the universities and the companies. But I do not see us reaching that level.

In summary to a rather lengthy reply to your question, I think this university/industry research interaction has been a very healthy thing. I think we are on firm ground and that the activity needs to be encouraged.

Senator DANFORTH. Dr. Wong, you have spent your academic career in a public institution, Berkeley. Yesterday President Benno Schmidt of Yale and Bob Rosenzweig, the President of the Association of American Universities, met with some members of the Finance Committee and the Ways and Means Committee about the effect of U.S. tax policy on higher education.

One of the issues that was discussed was the effect of the cap on institutions for tax exempt bond funding. Do you happen to know anything about that issue?

Dr. WONG. Not really, Senator.

Senator DANFORTH. Well, their thought was this, that what we did in the 1986 Tax Act was to place a limit on the bonding capacity of universities and this affects private universities more than public because public institutions can issue government bonds.

But their thought was that, insofar as the Federal government has, in effect, restricted borrowing, it has a disproportionate effect on research universities. Do you or do either of you have any thoughts about the needs of our research universities for capital expenditures in order to do the work of academic research?

Is it something that is going to be of serious concern in the years ahead? Is it something that we should be thinking of in the years ahead? Were the university presidents who were present yesterday

simply crying wolf, or is it something we should be addressing here in the Congress?

Dr. WONG. I do not think it is at all crying wolf. I think it is indeed a serious problem. The capital structure or the infrastructure of American universities to support ever-expanding roles in both education and research is a serious long-term problem. I think we need some long-term thinking and long-range planning in addressing these problems.

I do not think a solution can be effected overnight. I think we need some planning and some general approaches to the infrastructure problem. It is indeed a serious problem. Even though I am from a public university, a State university, I went to a private university. I am a strong supporter of the private university system. I think we in the public universities are better off because of the strength in our private university system.

So I certainly very much support some plan addressing the issues of infrastructure and the capital structure.

Dr. PHILLIPS. I would certainly agree with Dr. Wong. I think it is a very serious problem, that our private research universities are an exceedingly important component of our national technology effort, and that they are strapped. I think relief is essential. This is not calling for handouts but is calling for an ability to raise the requisite capital so research laboratories can be refurbished and brought up to date. I think it is a very crucial problem, Senator.

Senator DANFORTH. My understanding is that the cost of the equipment, the cost of the laboratories, is very high. I know nothing about science.

Dr. PHILLIPS. This is absolutely true.

Senator DANFORTH. The capital costs that are necessary for first-rate research——

Dr. WONG. Is enormous. And also the building, the facilities, the overall facilities to house the research. The cost is very great.

Dr. PHILLIPS. We are not talking about gold-plating either. It is difficult to do competitive research without the requisite facilities.

Senator DANFORTH. You cannot just pass the hat to get the money. As I understand it, you have to have some source of very substantial funding, which means borrowing in some cases by the institutions to get it done.

Thank you. Thank you, Mr. Chairman.

Senator GORE. Thank you very much.

Let me ask a couple of follow-up questions. First of all, on the relationship between universities and corporations, I trust that both of you are sensitive to the dangers of not doing that carefully. There have been some agreements between companies providing funding and universities receiving the money which have required scientists to obey a gag rule when they attend scientific meetings, to agree not to publish the results of their scientific research, or to agree to withhold publication for some period of time, during which the commercial value can be exploited.

Am I safe in assuming that both of you are sensitive to the concerns which can be aroused by going about this in a less than careful way?

Dr. WONG. Yes.

Dr. PHILLIPS. I think we are very sensitive to this area. But these concerns can be handled satisfactorily if everything is up front at the beginning.

Senator GORE. Well, they can be handled, and some institutions are handling them quite well. When this trend began, there was not a great deal of sensitivity to the dangers. Since that time, after a great deal of discussion, there is a lot of sensitivity and those institutions who feel they can afford to say no are extremely sensitive.

Other insitutions, perhaps because they have a harder time saying no, have not been as sensitive and continue to enter into agreements which do serious damage, in my opinion, to academic freedom and to the nature of the scientific research enterprise.

I would hope that insofar as you two see part of your agenda to be the encouragement of closer ties that you will also be extremely careful to promote the kind of sensitivity which has been referred to here and which is not always incorporated into the agreements that I see reported from time to time between corporations and universities.

Let me shift gears to semiconductors and Administration policy. Dr. Phillips, the recent report of the National Advisory Committee on Semiconductors contains a startling statistic about this critical industry. In 1970, when the first integrated circuit memory chip was sold, Japan's market share was zero; today, Japan holds nearly 80 percent of the world market in memory chips.

This decline in market share clearly makes it harder for U.S. firms to finance new generations of research and factories. The Advisory Committee has offered a number of thoughtful recommendations on how to reverse this decline, but there has not as yet been any concrete response from the Administration. Aside from continuing support of SEMATECH, a step with which I strongly agree, what specific proposals has the Bush Administration made to keep the United States competitive in semiconductors?

Dr. PHILLIPS. In response to your question, Senator, first, some of the statistics in that report were just slightly misleading in the sense that the captive market in the United States really was not included—that is, what IBM and AT&T use internally. So the numbers, while I agree are alarming, are not quite what was at least implied superficially in the report.

Senator GORE. Well, the report said that Japan's share went, in 20 years, from zero to 80 percent of the world market. If you factor in the captive markets——

Dr. PHILLIPS. It brings it down to something less than the 80 percent, but it is still very alarming.

Senator GORE. Would it be 75 percent?

Dr. PHILLIPS. Seventy, perhaps.

Senator GORE. Seventy percent. So zero to 70 percent in 20 years, and we have gone from 100 to 30 percent in the same period of time.

Dr. PHILLIPS. Let me just say, Senator, first off this area has not been something I have been involved in up to this point, but my understanding is that the report is being taken very seriously by the Administration and that there have been a number of discussions of the report within various parts of the Administration.

This is the initial report. There are ongoing meetings that are scheduled. There will be another meeting involving this group, OSTP being deeply involved, in March, and as far as recommendations are concerned I can only say it is being taken very seriously by the Administration. It is the first of a series of studies on this subject, and it will be a continuing interest to OSTP to come up with the proper recommendations and actions.

Senator GORE. I would simply suggest that furrowed brows will not substitute for concrete recommendations on how the country can respond, and we in Congress have been waiting for specific and comprehensive proposals as a result of that particular report. Many of us are concerned that the United States should not completely lose the competition in semiconductor technology.

Now with respect to high technology industries in general, in your written answer to one of the Committee's prehearing questions you say: "Individual U.S. companies simply do not possess the resources to respond in a timely fashion to global challenges from companies like those of Japan that play by different rules and that can operate in macroeconomic environments more favorable to long-term investment in R&D and modern manufacturing facilities."

As an expert with long experience in business, how do you think that the rules and macroeconomic environments differ in Japan and the U.S.—I know that is an expansive question; if you can just give a short response—and, in your judgment, what concrete changes would you like to see in U.S. policy—technology policy and macroeconomic policy—before U.S. companies can compete effectively with their Japanese counterparts?

Dr. PHILLIPS. Mr. Chairman, a number of things, some of which are under way. For example, I think it is important that the research and experimentation tax credit that has been proposed by the Administration be enacted, and, if anything, that it be increased and, most importantly, that it be done in a way that industry can see a continuity of purpose. That is, industry needs to know exactly how far to look ahead because R&D is not a short-range proposition.

I think that in the area of protection of intellectual property rights, we have been somewhat sloppy and that in negotiating with the Japanese, as with other countries, we have to protect U.S. intellectual property rights. Quite frankly, we have given away a lot.

I alluded in my opening statement to the need for making the investments in research and development and in plant capacity to enhance our competitive posture. We are working under a severe penalty because of our high cost of capital in this country. I think it is obvious that we need to bring our debt down. We need to increase savings. I think if we go into, as has been proposed, a capital gains tax reduction that this action be done on the basis of long-term capital gains because this is the kind of investment that we need and that our industry finds difficult to get in the United States.

Senator GORE. All right. Dr. Wong, you are one of the nation's top computer experts. As you know, I have long believed that supercomputers and computer networks are among the most important tools the Federal government can make available to our scien-

tists and researchers and engineers, and I believe that new research and equipment in the computer field will pay great dividends for the United States.

I gather that you support the high performance computing initiative that OSTP has developed in response to the legislation which I authored several years ago. Let me ask you three questions about the high performance computing initiative.

Number one, do you agree that advanced computing has made possible an entirely new way of performing research and that it is important for American science and technology that our country stay in the forefront of this field?

Dr. WONG. I do indeed.

Senator GORE. Some have compared this to a brand new branch of knowledge creation—inductive reasoning, deductive reasoning, computer simulation.

Dr. WONG. I would put it more as a change in the environment in which research can be done. It is an enabling process. It is a very major enabling process.

Senator GORE. Do you agree that one of the limitations in that enabling process as it currently exists is the inability of different teams of researchers in widely separate geographic locations to communicate with each other in real time with the data flows now necessitated by graphics and visualization of the sort necessary to present for the human mind what these new supercomputers can display?

Dr. WONG. Yes, but I would probably expand on that a little bit. I think because this capability has not been in existence before, perhaps the need for it has not been felt as much as actually is the case. I think the existence of a very high bandwidth, very high speed communication network will provide ways of collaboration, ways of teamwork that we do not even realize yet.

Senator GORE. Well, I certainly agree with you. Although climate research is not covered in the fields you will be discussing, I have worked in that area a bit. In looking at the Mission to Planet Earth, we are attempting to collect vast quantities of new information about changes in land use on the surface of the earth, the distribution of clouds around above the surface of the earth.

And yet we have in computer data banks vast quantitites of information which has never been examined, partly because we do not have the easy capacity to share this data and the analysis of the data between and among different teams of researchers.

More than 95 percent of all the LANDSAT photographs of the earth, for example, have never fired a single neuron in a single human brain—a resource that has not been exploited precisely because we do not yet have the kind of information infrastructure which could lead to dramatic advances in the productivity of scientific research.

Now, secondly, if confirmed, what role will you play in coordinating the Federal agencies involved in the computer initiative and how much money will you seek for the fiscal year 1992 budget?

Dr. WONG. I think the role of OSTP in coordinating Federal agencies activities in this area will be vital. I think above all we need a coherent plan and that means a vision of where we want to get to.

Senator GORE. We have got the plan. We have the plan. If I may interject this point, we required the preparation of the plan in legislation this Committee passed. The OSTP responded in a magnificent fashion with a very comprehensive plan. We think it can be proved a little bit here and there, but the plan itself is excellent.

What we do not have is the money.

Dr. WONG. I hope to participate in the process of shaping the 1992 budget so as to make sure that this area is supported.

Senator GORE. Being as we are all nice guys here, we are going to let you off the hook with that response. But the subject will be revisited in weeks and months ahead.

Dr. WONG. Senator, let me just say that is, in terms of short-term priorities, my number one priority.

Senator GORE. Great. Well, I am delighted to hear that, and that answers the third question that I was going to ask you.

I have other questions for the record. You have already been very kind to answer a series of excellent questions from Senator Hollings for the record. I am going to ask you to respond to a few more for the record.

But I personally am quite satisfied with your credentials and qualifications for the positions to which you have been nominated. I foresee no problem in speedy approval. I cannot speak for my colleagues, but I almost can because I know of no objection to your nominations. Your reputations speak for themselves. I trust and expect that action will be forthcoming fairly quickly.

I wish you well and look forward to working with you. With that, our hearing is adjourned.

[Whereupon, at 10:45 a.m., the Committee adjourned.]

[The following information was subsequently received for the record:]

DR. PHILLIPS' RESPONSE TO SENATOR GORE'S POST-HEARING QUESTIONS

1. QUESTION: I am pleased to see that the Bush Administration supports the idea of developing new generic technologies to help both the mission agencies and private industry. Which generic technologies do you and OSTP believe are most important to develop, especially in order to help keep U.S. industrial technology strong? What are your priorities, and how do you set your priorities?

ANSWER: **In response to the requirement of the FY 1990 Defense Authorization Act, OSTP is setting up a panel to identify national critical technologies. Those are technologies that are determined to be "essential for the United States to develop to further the long-term national security and economic prosperity of the United States." The panel's first report will be submitted to the President on October 1, 1990, and transmitted to Congress 30 days thereafter. At that time we will be able to answer your question more specifically.**

I would anticipate that many of the technologies that we identify will coincide with those already on the Defense Critical Technologies list. A considerable amount of Federal R&D is already being performed in those areas. In addition, the Administration looked at several advanced technologies as part of the FY 1991 budget process in order to determine total Federal spending for those technologies. That type of aggregated review will be continued in our examination of critical technologies.

2. QUESTION: Both the Japanese government and the European Community are now investing huge sums into industry-related research. In addition to traditional projects supported by MITI and other Japanese agencies, we now see the Japan Key Technology Center. Regarding Europe, I have seen estimates that say as much as $16 billion will be spent on high-technology research over the next several years, with half this total coming from government. Yet, while several Federal agencies monitor foreign technical progress, no agency has the mission or resources to follow foreign R&D spending in specific areas of advanced technology.

- Since Federal agencies do not monitor foreign technology spending closely, how do senior government officials now get reliable information on foreign investment in technology.

- If information is lacking, how can our government make sound decisions about which technical areas need support in order to maintain U.S. technological competitiveness?

ANSWER: **There are several government agencies that provide information on foreign investments in technology. For example, the various intelligence agencies, Department of Commerce, Department of State, and National Science Foundation all gather and publish data which are available throughout the government. In addition, industry associations are a very important source of data on foreign R&D spending.**

The thrust of the question seems to be that the government needs the best possible data on foreign competitors before it can make appropriate decisions for investments in technology. I agree. However, the government has a poor track record where it has invested in civilian technology without close involvement from the outset of potential users. If U.S. industry needs government assistance and asks for it and is willing to coinvest, then there is some hope of success. On the other hand, if industry does not perceive the need or is not interested, there is little point in the government's engaging in technology push. That is a lesson we have from past history, and we should try to avoid similar mistakes in the future. All of this is not to say that the government should not be involved in identifying enabling technologies critical to the national competitiveness posture.

3. QUESTION: I am concerned about whether a technology perspective is being considered when the United States makes foreign policy. Just recently, for example, the U.S. government has decided to agree to a proposal to let Soviet rockets carry commercial payloads from a new site at Cape York, Australia. I do not know the precise merits of this case, but apparently neither OSTP nor the U.S. Trade Representative played any role in this decision, even though subsidized launches in other countries have major implications for the competitiveness of the U.S. commercial space industry.

QUESTION: Does OSTP play any role currently in Administration decisions that affect the international competitive position of our high-technology industries?

ANSWER: OSTP plays a central role in determining Administration policies relating to our international competitiveness including high-technology industries. Title II of PL 94-282 gives OSTP responsibility to "assess and advise on policies for international cooperation in science and technology which will advance the national and international objectives of the United States." There are a number of ways in which OSTP accomplishes this legislative responsibility, particularly in the area of high-technology industries and international competitiveness.

As Assistant to the President, Dr. Bromley serves on Domestic Policy Council, the Economic Policy Council and other White House councils considering issues relevant to our global competitive position. In addition, Dr. Bromley has taken steps to strengthen the Federal Coordinating Council on Science, Engineering and Technology which will serve to coordinate our federal science and technology efforts in the United States at the highest levels. To address the specific concern of the competitive position of our high-technology industries he intends to appoint a Technology and Industry Committee of the FCCSET.

To ensure that appropriate advice from the private sector on this and other important science and technology issues, the President appointed 12 distinguished individuals from academia and industry to the President's Council of Advisors on Science and Technology. Dr. Bromley has been asked to chair this group to ensure that the advice flowing from this prestigious panel is integrated into federal science and technology policy.

QUESTION: If confirmed, how will you and Dr. Ratchford work together to monitor how State Department decisions affect U.S. industrial technology?

ANSWER: Dr. Bromley has made clear, both in his confirmation hearing and in practice, that he intends that all four associate directors of OSTP to work together collegially to address, cooperatively, the issues involving science and technology. Dr. Ratchford and I will discuss issues that cut across industrial technology and international competitiveness. For example, in addition to establishing a FCCSET Committee on Technology and Industry, Dr. Bromley is also strengthening the FCCSET Committee on International Science, Engineering and Technology. I will coordinate with Dr. Ratchford on the many issues that cut across these two fields, The Department of State has an important interest in both these fields.

OSTP currently reviews all government-to-government and agency-to-agency science and technology agreements with other countries to ensure consistency with U.S. science and technology policy. I will work closely with Dr. Ratchford in that process when industrial technology concerns are raised. In addition, Dr. Ratchford and I will work with the Department of State to ensure that more of these agreements do incorporate access to foreign technology where appropriate, without jeopardizing U.S. competitive position. We also will discuss with the Department of State the need to incorporate industrial concerns in next year's Title V Report.

4. QUESTION: You have great experience with state technology programs, having served as Science Advisor to the Governor of Missouri.

In your view, what do you believe are the two or three most useful things that Federal research agencies and technology extension programs can do to help states boost economic development and improve manufacturing?

ANSWER: Let me respond to this question with a general statement which, although it may appear to be platitudinous, I nevertheless believe: Above all, without insinuating itself as the focal point, the Federal government and its arms and agencies must seek out every means it can to assist in providing a focus for problems and opportunities at the local level and to bring together state, private and academic elements for solution of problems and taking advantage of opportunities. In some instances, this will require provision of funding (often matching) and other services for problems and opportunities that transcend state boundaries. In other cases, only leadership and provision of the requisite national/international climate will be required.

To be somewhat more concrete, we must maintain and even enhance Federal support of basic and applied research programs in our universities and at NIH. These programs are the engine that powers much of our industrial capability at the state as well as national level.

We must ensure that agencies such as FDA and the Patent Office are adequately staffed so that their essential regulatory functions are expeditiously and comprehensively executed.

Every encouragement should be given to DOC to become even more responsive to the needs of the industrial base of the states.

Through leadership and tax and regulatory reform, joint ventures and collaborative interactions between companies, between companies and universities and between companies and Federal laboratories require encouragement.

Encourage and assist state initiatives to enhance capabilities of small businesses in such areas as flexible and computer integrated manufacturing, quality assurance, and such seemingly mundane business practices as use of computers in inventory control, bookkeeping, payrolls, etc.

6. QUESTION: Please attach a list of current and planned committees and subcommittees of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). Please give each committee's and subcommittee's name, a short description of its responsibilities, the name of its chairperson, and the name of the OSTP associate director or staff person, if any, who works with the group.

ANSWER: The FCCSET structure is in the process of revitalization and reorganization. An array of umbrella committees are being established in such areas as health and the life sciences, the physical, mathematical, and engineering sciences, and education and human resources. Various subcommittees will be formed under these committees in such areas as high-performance computing, the social and behavioral sciences, and materials science and engineering. The intention is to cover the broad range of issues in science and technology that rise to the Presidential level. The full organization of FCCSET will be provided as soon as it is in place.

POST-HEARING QUESTIONS FROM SENATOR PRESSLER
DR. WILLIAM D. PHILLIPS

1. QUESTION: In your work for the Missouri Advanced Technology Institute, and for the Governor of Missouri, you worked with several different collaborative manufacturing projects. Are other states undertaking similar initiatives? Are they successful? Are they important? Can the programs be applied in less industrialized states, or do they only work where there is a solid manufacturing and research infrastructure already in place?

ANSWER: **Virtually every State has in place some activity whose objective is to improve its industrial competitiveness. Some programs are ambitious, some are modest. Factors that have been conducive to success in these programs include the presence of quality research universities, an industrial base, Federal laboratories and the availability of seed and venture capitol.**

In addition, the states that have been successful have been prepared to make the long-term substantial investments that are essential to success in this frankly difficult endeavor. Finally, without determined and uninterrupted leadership from the Governor and the state legislature, little will be accomplished. In my view, every state that has made a serious effort in improving its level of competitiveness has profited. The Federal government can help in a variety of ways. However, I firmly believe that it is the responsibility of the individual states to formulate and implement programs that are consistent with their individual circumstances. Without strong local commitment and involvement, Federal programs in this area of dubious value.

2. QUESTION: How can a rural state like South Dakota take the greatest advantage of its dispersed technical resources and research enterprise? How can the Federal government help states like South Dakota establish collaborative efforts to leverage existing technology programs? Will you be involved in formulating the government's role in these activities?

ANSWER: **The problem of basically rural states such as South Dakota in leveraging existing technology programs is a good deal more difficult than for states that possess strengths in a number of the success factors alluded to in response to your first question. Nevertheless, states such as Arkansas have demonstrated a good deal of success with aggressive and well-conceived programs. Finally, I would assure you that this area will be a priority concern of OSTP and myself.**

POST-HEARING QUESTIONS FROM SENATOR GORE TO DR. WONG

Question 1. What steps will OSTP take over the next year to implement the high-performance computing initiative? What planning will be done, what projects will receive the most attention, and how will OSTP participate in the deliberations leading up to the President's fiscal year 1992 budget request?

Response to Question 1. Several steps are being taken. First, a High Performance Computing Advisory Panel, as called for in the initiative, is being formed as a working panel of the President's Council of Advisers on Science and Technology (PCAST).

Second, Dr. Bromley has convened a group of senior officials from the principal participating agencies (including the Deputy Secretaries from Defense, Energy and Commerce) to initiate implementation of the HPC plan. This group will eventually be established as a permanent FCCSET (Federal Coordinating Council for Science, Engineering and Technology) Subcommittee on Information Technology and will have primary responsibility for implementing the budgetary plan of the proposal. With the high level representation on this committee from the principal participating agencies, I am optimistic that the FY 1992 budget cycle will improve coordination and lead to a more coherent budget.

Question 2. You and I are both strong supporters of university basic research. I want to ask you what you think are the most important needs in this area, and I'll phrase the question this way: If you had an extra $50 million or $100 million to use to support research in universities, how would you use it? Would you spend it on research grants and, if so, in which fields of science and engineering? Or would you spend it on infrastructure, such as new equipment and laboratories?

Response to Question 2. The President's budget provides a high level of support for basic research at universities. "Small science projects" are the most basic part of basic research and additional funds could provide additional benefits. This area is where I would spend the extra money. Small projects that support individual researchers must continue to be supported.

Question 3. I want to ask you about long-term research and technology development within Federal agencies. I see the computer initiative -- and the funding problems it is encountering -- as an example of a larger issue. Federal agencies not only need to help industry develop the new commercial technologies of the future; they also should make new advanced technologies required to carry out Federal missions. Yet I see a whole range of agencies, including NASA, neglect technology development. They are pushed to squeeze their budgets in order to pay for operational programs or large new projects. I don't blame the agencies, but I do believe that we must rethink our research priorities.

- Do you think that we will have a successful space program in 20 years if we fail today to study new propulsion systems, new materials, and advanced robotics and automation, and life sciences? Will agencies stay at the edge of research if they neglect scientific computing? How will DOD build the advanced weapons it needs a decade from now if

the Administration succeeds in cutting $149 million out of DARPA's research budget in the next fiscal year?

- What do you think of the idea of requiring each Federal mission agency to set-aside part of its research budget to support advanced technology development in such areas as computers, advanced materials, and process technology?

Response to Question 3. **Different agencies ensure the availability of needed technologies in different ways. In computers, for example, DARPA does it by supporting research and development, while others have done it by purchasing new models. I think that this flexibility is healthy and would not want to require each agency to fund research in every technology that it needs.**

Question 4. Traditionally, NSF and other Federal agencies have emphasized basic science when funding university research. Engineering, for example, was relatively neglected by NSF until recent years. While you and I agree that agencies must continue the support of basic science, I was interested to read your comment that manufacturing deserves a much greater level of attention. You added that in addition to providing more funds, we need to manage our manufacturing research better.

- In your judgment, why have U.S. funding agencies and universities neglected research in manufacturing? Has manufacturing lacked "sex appeal," despite its great economic impact?

- How much is a "much greater level of attention"? And how do you recommend that manufacturing research in universities and Federal laboratories be managed?

Response to Question 4. **Universities were not the only ones to neglect research in manufacturing. So did industry. Happily, the situation is changing, and major university engineering schools are very much interested in manufacturing. However, it is difficult to do realistic experiments on manufacturing in a laboratory setting. Thus, university based projects tend to be somewhat peripheral, e.g., robotics or software for manufacturing support. This is an area where university-industry collaboration is essential.**

Manufacturing research should be undertaken with a focused goal, a well-designed plan with alternate approaches, and hands-on management until the goal is reached. In this framework, manufacturing in general is too broad a topic.

Question 5. I do not necessarily oppose the Superconducting SuperCollider (SSC), but I wonder why we are spending $7 billion or more on a single project with no practical benefits when, as you have pointed out, research in manufacturing has been starved and when the computer initiative that we both support has received only $21 million in the President's latest budget request. I know you need to defend the SSC, but as an expert observer, can you tell me why the Federal government has repeatedly invested in incredibly expensive atom-smashers while neglecting areas of much greater practical importance?

Response to Question 5. **I think the mega-projects should be considered separately from basic research. The latter can be justified as economic investments alone and its level of funding must be kept at a level necessary for our future economic well-being, whether or not mega-projects are funded. I urge that there be no trade-offs between these two categories.**

Mega-projects such as the SSC are justified by a mixture of motives: national prestige, scientific adventure, and socio-economic spin-offs. The particular balance among these that allows one project to be supported and another not is a political decision that political leaders must make.

Question 6. In your answer to one of the Committee's pre-hearing questions on recruiting scientists and engineers, you spoke of the need for the more timely motivation of students and the need for an adequate level of support and encouragement. How can we accomplish these two tasks? What needs to be done? And what role, if any, can Federal science and technology programs play in this process?

Response to Question 6. **There are many conventional suggestions on how to better motivate high school students. Personally, I think the problems are deep rooted, and conventional approaches such as better teaching, better textbooks, and better counseling will at best bring incremental gains.**

If students are not ready when opportunities strike, then why not make opportunities available when they are ready? Basically, this means creating additional educational opportunities for young adults. If our goal is to develop all the human potential that exists in our society, why insist that this potential be measured only at age 18? My experience in dealing with this problem over the last five years makes me a strong advocate for re-entry and late-entry programs. I think in terms of leverage, building these programs is likely to be more effective than strengthening high school programs.

Question 7. Among other things, Dr. Wong, you are an example of a great American tradition -- the professor who helps start a high-technology company. I understand that you were a founder of INGRES Corporation, a software company. What problems did you find when you and your partners sought to start a new company? Would something like a university incubator center have helped? Are there steps that universities, state governments, and Federal agencies can take to help academic entrepreneurs start and prosper?

Response to Question 7. **We faced many problems, but the most difficult one by far was to build an effective management team quickly. This is where a strong venture-capital investor is invaluable. Their access to the business community and to strong management candidates is just as important as the money they bring.**

I don't believe the incubator concept is essential, but in some situations an incubation process may be useful. The transition between usable research results and marketable products and services is not an easy one. Some start-up companies fail, because the transition is particularly difficult and slow, and the start-up capital is spent prematurely. In such cases, an incubator would help. However, incubation is a business process and must be managed by people with

start-up experiences – not scientists, not academics, not government officials, not even business executives with mainly big company experiences.

Finally, I think that, by and large, American entrepreneurship is alive and well. The real problem of American business is the inability of start-up companies, however successful, to reach a size comparable to their international competition. In the electronic-computer industry, for example, many post-war companies have reached $1 billion per year in revenue. Two (Apple and Sun) did it in a half-dozen years! Yet, only one (Digital) exceeds $10 billion in annual revenue. These companies have to compete internationally against the likes of NEC, Hitachi, Mitsubishi, Siemens, and Philips, all much larger and more integrated enterprises. I have no solution to offer on this problem, but it deserves more attention than it has received.

POST-HEARING QUESTIONS FROM SENATOR PRESSLER TO DR. WONG

Question 1. What is the best way to ensure the high quality of research at universities in rural states like South Dakota? Will a high performance computer network help? If so, how will you factor those needs into your plans for implementing a high performance computer initiative?

Response to Question 1. I think there are several ways in which the high quality of research at universities in rural states can be ensured. First, a high-speed network for communicating not only computer data but visual and other sensory information will certainly help. Participating in regional consortia of research institutions, and establishing partnerships with larger universities are possibilities to be explored. Such cooperative arrangements would be greatly aided, and their value enhanced, by a high-speed digital network.

Question 2. In your answers to Senator Hollings's pre-hearing questions, you state that manufacturing deserves a much greater level of attention from all sectors of our society, and that in addition to providing more funds for manufacturing, we need to manage our manufacturing research better. What can we do specifically to improve our research in manufacturing? Do we need a more coordinated approach? Better goals? Different programs? Who should coordinate those efforts?

Response to Question 2. I think manufacturing research should be managed by a major components, with focused goals identified for each one and programs designed and managed to successful conclusion. Some of the DARPA efforts in electronics and computer technology represent good models for management. Examples include: very large-scale integration (VLSI), computer communications (ARPA Net), and submicron fabrication. I think coordination is less of an issue than managing, and who does it less important than how it is done. DARPA has been successful in part because of the following characteristics of their process: (a) their budgets are large, (b) they attract some of the best scientists to serve stints as managers, (c) post-award management of contracts receive as much attention, if not more, as pre-award selection, and (d) projects are pursued to conclusion.

POST-HEARING QUESTION FROM SENATOR DANFORTH FOR DR. WONG

Question: The Nation's universities play a crucial role in support of America's research and development enterprise. Universities perform over half of all Federally sponsored basic research. However, universities in virtually every state need help in constructing new research facilities and upgrading existing facilities. Two years ago, the Commerce Committee authorized funds for a facilities upgrade program, but only a small amount of money has been budgeted to fund the program. In the meantime, members of Congress have been earmarking funds for special projects at universities in their home states. This practice diverts scarce research dollars from deserving projects and establishes a haphazard system of special appropriations for facilities projects. If confirmed, what will be your role in developing a sensible Federal policy to assist American universities in improving their research facilities and laboratories?

Response: I fully agree that Congressional support for projects at favored universities is not the solution to the problem of providing adequate facilities and infrastructure. Personally, I think we need to find a long-term approach and one that recognizes the shared responsibility of government, universities and the private sector. This issue is receiving much attention including a major effort from the Government-University-Industry Research Roundtable. I have not had an opportunity to discuss this within OSTP. I hope to have an opportunity to initiate such discussion.